

## CHARGING AND DISCHARGING OF SINGLE SILICON NANOCRYSTALS: MEASUREMENT AND MODELING

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Nanocrystal nonvolatile floating gate memories are a good candidate for a commercial nanoparticle device - initial results suggest they are fast, more reliable and consume less power than conventional floating gate memories. To investigate the charge trapping characteristics of nanoparticles suitable for such devices, we have developed an aerosol method for the synthesis and size classification of silicon nanocrystals with 10-15% control of size in the 7-30 nm size range. We have used conducting-tip atomic-force microscopy (AFM) to spatially and electronically manipulate single silicon nanocrystals on an insulating substrate (a 100 nm thermally grown SiO<sub>2</sub> layer on silicon). By applying voltages of 20-40 V to a conducting AFM tip and contacting the silicon nanoparticle, we have injected charges on the order of 10-100 electrons. We have also used the AFM to observe the discharging of the nanoparticle as a function of time in a dry, nitrogen-purged atmosphere. Typical discharge times range from 1000-10000 s. We have used a simple ('noncontact') and more complex ('tapping') model of the AFM interaction with the sample and electrostatic forces in order to estimate the amount of injected charge and to investigate the discharging dynamics. From the model, we estimate the sensitivity of this charge detection method to be on the order of 3-5 electrons.